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1. Message from the Chairman

Dear friends,

The eternal city of Rome was the place of several very successful ITA COSUF events on 21-22 June. After hard work during the Steering Board meeting on the first morning and Activity Group meetings in the afternoon was finished, our Italian organiser-in-chief, Roberto Arditi, introduced us to Roman houses of the early Christian period with a visit of the historical houses of Celio, below the St John and St Paul basilica. The next day started with the ITA COSUF General Assembly, which was followed by the very interesting and well-attended workshop co-organised by ITA COSUF with the Italian National Committee of PIARC under the auspices of the Italian Higher Council of Public Works (see section 5 below). Many thanks to our Italian hosts for the hearty welcome and perfect organisation!

Important changes in the Steering Board membership were decided during these events. The three most ancient members decided to resign so as to allow new members to be appointed. It is with mixed feelings that I see Kees Both (Promat, NL), Niels-Peter Hoj (Hoj consulting, CH) and Jan Mijnsbergen (CUR, NL) leave the board. We have been working together since the creation of COSUF in 2005, and as a matter of fact since long before: we took part together in the European thematic network FIT (2001-2005) and research project UPTUN (2002-2006), and started the preparation of COSUF several years before it was officially created. On behalf of all ITA COSUF members, I very sincerely thank them for their pro-activeness and dedication to develop COSUF from just an idea 8 years ago to the active, competent and well-known network it is now. I also congratulate them for acting in a very responsible and difficult way by leaving their seats on the Steering Board to allow new people to take part. Special thanks go to Jan Mijnsbergen who has acted as General Secretary from the very beginning, with all the important and sometimes tedious work to ensure smooth running of COSUF. Of course, the three of them will continue active participation in the other ITA COSUF activities, like Activity Groups, workshops, etc., and this will give us the opportunity to continue to benefit from their experience, enthusiasm and, very importantly, their presence and friendliness. I also reiterate the many thanks and congratulations I gave last



year in this Newsletter to our past chairman, Felix Amberg, who has also resigned from the Steering Board when he left chairmanship; fortunately for us, he still attends the meetings as ITA Tutor. These four leaving Steering Board members have drafted a message for us and you will read it in section 2 below. Although he left one year before, when he retired, I extend our thanks to Evert Worm (RWS, NL) who had been involved since before the creation of COSUF.

I would now like to welcome on board the Steering Board the four new members who have been elected by the last ITA COSUF General Assembly: Roberto Arditi (Sina, I), Johan Bosch (RWS, NL), Haukur Ingason (SP, S), Max Wietek (Hagerbach Test Gallery, CH). At the same time, it is a pleasure to welcome the new representative appointed by PIARC: Gary Clark (Atkins, UK). I wish all of them a fruitful, rewarding and also pleasant activity on the Steering Board and trust their skills, experience and views will still increase the momentum of ITA COSUF (see section 3).

We also have a new vice-chairman and I wish to congratulate the appointee, Roland Leucker (Stuva, D), whom everybody already knows as a very active Steering Board member. The new team is complemented by the appointment of Ben van den Horn (Arcadis, NL) as General Secretary: he replaces Jan Mijnsbergen in this position, while continuing his activity as leader of AG1.

The Rome workshop was the opportunity to officially present the ITA COSUF 2012 Award to Dr. Ying Zhen Li, a young Chinese scientist who currently works at SP (SE). The award rewards his persevering and successful work to advance the important and quickly-developing topic of tunnel fire dynamics. He gives us a state-of-the-art in section 7 below.

The next time for all of us to meet will be the meetings and workshop planned in Madrid on 25-26 October. The activity group meetings on 25 October afternoon will be followed by a technical visit to the very interesting Calle 30 tunnels. On the next day, a workshop on "Safety in complex underground traffic infrastructures" will be co-organised with AETOS (the Spanish Tunnelling Association), ATC (the Spanish Road Association) and PIARC. I trust that all ITA COSUF members will attend these important events (see section 4).

Finally, I would like to mention two important events endorsed by COSUF this year. On 27-28 June, the final conference of the SOLIT² project took place in Berlin with about 100 participants. It was the opportunity to discover the results of this important research project on fixed fire-fighting systems in tunnels and receive a first version of the final report. The lively half-day session organized by ITA COSUF gave the opportunity to widen the scope with experience from other countries and backgrounds. Finally, I remind you that next November, during the 13th World Conference of ACUUS (Associated Research Centres for Urban Underground Space) in Singapore, ITA COSUF will organise a one-day workshop devoted to Safety and Security of Underground Operations (see section 8).

Looking forward to meeting you at our Madrid meetings and workshop,

Best regards,

Didier Lacroix



2. Four founders of ITA COSUF are stepping down from the Steering Board

In autumn 2004, more than 100 European companies and institutes were involved with European R&D-projects concerning safety in tunnels. In order to sustain the momentum of the professional network, and to disseminate the unique knowledge obtained from these projects within the community of the Underground Structures and Safety Engineering, ITA COSUF was established. It was decided to create the committee as an autonomous entity in ITA with endorsement by PIARC.

The press release after ITA's General Assembly in Istanbul, 2005, said:

*"ITA COMMITTEE ON SAFETY OF TUNNELS IN OPERATION
Chairman: A. Haack (ITA); Vice Chairman: D. Lacroix (PIARC); Tutor: C. Berenguier (ITA)
The general assembly 2005 followed the proposal of the Executive Council to create a "Committee on Safety of Tunnels in Operation". The initiative started from the 7 EU launched research projects and networks in consequence of severe fire accidents in European road tunnels during the last couple of years. The project represents about 100 institutions, research companies, academic institutes, owners and suppliers from all over Europe. The committee will be open for all interested bodies worldwide. Alfred Haack from ITA was appointed as Chairman and Didier Lacroix from PIARC as Vice Chairman."*

In the spring of 2006 the first 'open' activity of ITA COSUF was its inauguration, which took place in connection with the Symposium "Safe and Reliable Tunnels" organised by two of the European R&D-projects.

We (Felix Amberg, Kees Both, Niels Peter Høj and Jan Mijnsbergen) were active in various of the European R&D projects and were instrumental in the establishment of the framework of the committee, the statutes, the organisation of the activity groups, and the links to ITA and PIARC. As founding members of the ITA COSUF Steering Board (SB), we are looking back into the past eight years with pride. The committee has reached a number of great achievements:

- ITA COSUF is now a renowned international organisation with unique identity within the community;
- ITA COSUF is a centre of excellence constituting a network of experts within safety and underground facilities;
- ITA COSUF has organised and incorporates the exchange of experience between safety officers;
- ITA COSUF is a highly collaborative environment with excellent working spirit;
- ITA COSUF has broadened its perspective from safety of tunnels to safety of underground facilities;
- ITA COSUF has created meaningful and regular activities, such as annual open workshops as well as committee-internal workshops, and Activity Group- meetings, which have brought experienced as well as young engineers from many countries together to share better practices.



*Left: Alfred Haack, COSUF's first chairman, at the inauguration in Lausanne
Right: Over 100 persons participated at the occasion of COSUF's inauguration*



COSUF's yearly workshops have a dedicated theme. The above themes passed during 7 years.

Presently, safety in underground facilities is ever more important. ITA COSUF is blessed with active members: such as experienced experts, high ranking officials and young professionals – all of them highly motivated colleagues. This network is the imperative success factor to ensure that ITA COSUF will continue to gain momentum and will prove to be a breeding ground for future successful projects. These will enable ITA COSUF to further develop its central role within the community.

In order to provide opportunity for the members of the committee to elect the steering board, we decided to step down from the Steering Board at the General Assembly 2012. We appreciate having been able to contribute to the success of the initial stage development of ITA COSUF. We would like to take the opportunity to sincerely thank all ITA COSUF friends, and especially the SB colleagues for the good collaboration in the last eight years.

We will continue to be active, in our different roles, within ITA COSUF, because we value the inspiring and motivating environment.

ITA COSUF is an excellent environment for professional networking and friendship within the society of underground structures and safety engineering

We wish you all, the SB members in particular, great success and excellent collaboration.

We are looking forward to meeting you soon again!

Felix Amberg, Kees Both, Niels Peter Haj and Jan Mijnsbergen



3. Short presentation of the new ITA COSUF Steering Board members



Professor Johan W. Bosch:

As new steering board member and leader of activity group 4, I would like to introduce myself. After obtaining an MSc in civil engineering at Delft university of Technology, I started working in the construction industry. Over time I have had different positions within Consultancy, Municipal organisations and the Government. From the start of my professional life I have been involved in major underground infrastructure projects like road tunnels and metros. A major part I spent on the planning and construction of the North South metro line in Amsterdam, a challenging project.

Today I divide my time between the chair of Underground Space Technology at Delft University of Technology as a professor and my job as a Tunnel Safety Officer for the state road tunnels in the Netherlands.



Professor Haukur Ingason:

At present I work at SP Technical Research Institute of Sweden. I have been working on tunnel fire safety for nearly twenty years. Large scale and model scale studies of fire and smoke spread in tunnels have been an important working field. I was involved in UPTUN as a project leader of the large scale tests performed in Runehamar tunnel 2003 which yielded heat release rates in a burning heavy goods vehicle mock-up up to 200 MWs. Most recently, I was a project leader for the METRO tunnel fire tests in Sweden which generated heat release rates up to 77 MW from a metro train. I am also a part time professor at Lund University in Sweden and a principal member of NFPA 502 standardization committee for road tunnels. I take part in the PIARC working group on water spray systems in road tunnels. I am looking forward to put energy and experiences as a SB member in the further development of COSUF.



Dr. Ing. Roberto ARDITI

Honored to have the opportunity to serve as a member of the steering board, here is my self-introduction. I am currently working as Director in charge of Scientific Affairs for the SINA Group. Since 1985, when at the age of 23 I achieved my Master of Science degree in Engineering, I've been contributing to multidisciplinary groups for the activities of design, works direction, study, assistance to the operation in many fields of the engineering, like infrastructures and equipment design, transport risks, technical/economic evaluations and evaluations of environmental impact. My European experience allowed me to perform the technical coordination of several European projects for studies and implementation of Intelligent Transport Systems. I have experience on a wide range of road tunnels issues and I am coordinating the activity of the safety officers for about 105 tunnel tubes longer than 500 m, i.e. about 185 km of tunnel (being also myself a safety officer).



Along my professional experience, I contributed to a number of Governmental, Intergovernmental and other Commissions of study. E.g. I was Expert and Member for Commissions of the Italian Higher Council of Public Works, I was member of the National Italian Board for the Forecast and Prevention of Main Risks (Italian First Minister Office), I am member of ASECAP and Aiscat (associations of motorway operators) Permanent Commissions, I was independent expert of the European Commission DG TREN, I am member of PIARC international technical Committee and currently chairman of the relevant Italian technical committee on “policies for road safety”. I was member and rapporteur of national policy commissions on road safety and road construction, into groups of experts of UN-ECE, etc.

4. Next AG meetings and workshop on 25-26 October in Madrid



The next ITA COSUF workshop will be devoted to Safety in Complex Underground Transport Infrastructures and will be held in Madrid on 26 October. It is co-organised with the Asociación Española de Túneles y Obras Subterráneas (AETOS), the Asociación Técnica de Carreteras (ATC) and the World Road Association (PIARC).

The density and complexity of our cities and the continuing urbanization require safe and efficient underground transport systems as one of the main foundations of our societal wealth. Due to varying conditions and history, different carrier systems – road, rail, metro – implement different solutions to ensure safety and efficiency. However, these different systems may learn from each other when it comes to installation and management of safety measures for an efficient operation of underground infrastructure.

With a focus on huge Spanish infrastructural facilities (such as Calle 30) and with the addition of international experts from prominent European projects (e.g. the channel tunnel) the organizers have put together a well-balanced program, tackling the aforementioned problems and aiming for informational and technical exchange between practitioners from various countries and backgrounds.

You are invited to register to the workshop by requesting a registration form (send an email to secretaria@aetos.es). Registration is free for ITA COSUF members.

The ITA COSUF Activity Group meetings will take place on the day before the workshop. More information will be sent to COSUF members by dedicated emails.



5. Report of the ITA COSUF Workshop in Rome, 22 June 2012



The beautiful Marconi Room of the CNR Building at Piazza Aldo Moro 7 in Rome was the setting for the ITA COSUF Workshop on 22 June 2012. This workshop was organized in cooperation with the National Italian Committee of PIARC, under the auspices of the Italian Higher Council of Public Works. The theme of the workshop was Safety versus Economics: Cost-efficiency of tunnel safety measures. The key words were global crisis, and optimal use of more limited resources when plan-

ning and building new underground facilities, or refurbishing existing ones. The number of participants was approximately 80 from 14 different countries.

A hearty welcome address and presentation of tunnel safety stakes in Italy was given by Mrs. Maria Pia Ciercello on behalf of Mr. Pietro Ciucci, chairman of the Italian National Committee of PIARC, before the opening speech by ITA COSUF chairman Didier Lacroix.



Zaw Zaw Aye



Roberto Arditi



Marc Tesson

The keynote lecture by Executive Vice President Zaw Zaw Aye from Seafco Public Company Limited (Thailand) was dedicated to climate change and safety of the Bangkok Metro, where severe flooding takes place from time to time and especially did during 2011. One of the issues is the safety of the Bangkok Metro and the speaker showed that Multi-Service Flood Tunnel System (MUSTS) are proposed for a better and resilient Bangkok.

After a brief discussion chaired by Felix Amberg (Switzerland) a morning session on Human behaviour and emergency started. Roberto Arditi of SINA (Italy) showed how Italian information campaigns impact on human factors. In this campaign 43 behaviours were identified, each of which a



cartoon and a message on road safety behaviours were drafted for. Roberto Arditi concluded that road safety is a commitment to be shared and that everyone is needed to spread the culture of safety and legality on the road. SINA is busy identifying new partners for scientific partnership and dissemination activities.

Marc Tesson of Centre d'Etudes des Tunnels (CETU - France) addressed the training of HGV drivers for safe behaviour in tunnels based on PIARC recommendations, and described its implementation in France. Heavy goods vehicles are the source of aggravating factors in case of fire in tunnel but they can be a real opportunity in evacuation situations: once some professional drivers take the initiative to flee towards exits, the others (non-professional drivers) follow them spontaneously. So, big stakes are involved in training professional users for a leadership role by setting a good example in a crisis situation. Marc Tesson showed that in France fruitful cooperation between experts in the field of driver education and in the field of road tunnel safety has been achieved, and he expects that French materials can easily be adapted to fit an international context. A possible further action could be to translate the material in English and to encourage other countries to implement it.

The last presentation in the morning session was on the training tunnel facility of Sorreley: design and plans for the joint training of emergency staff by Fabio Giovinazzo of the fire brigade of Valle d'Aosta Region (Italy). This tunnel is well equipped and capable of testing not only technical equipment such as thermal cameras but also emergency response procedures. After this presentation a discussion followed chaired by Niels-Peter Hoj (Switzerland).



Bart Duijvestijn

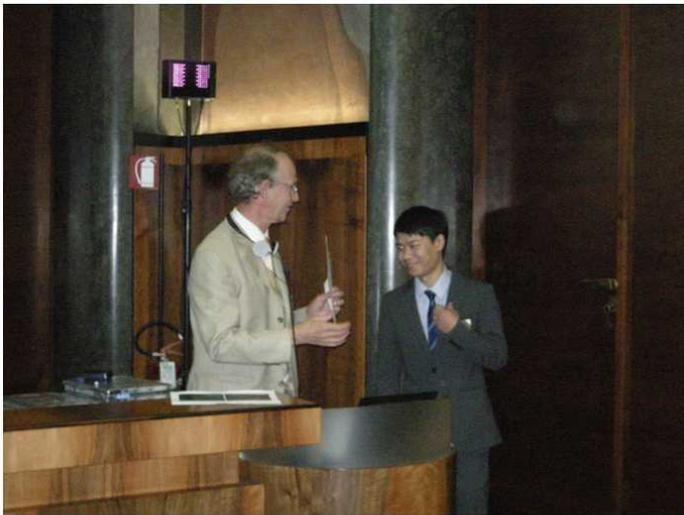


Jan Dirk Chabot

After lunch Bart Duijvestijn of ARCADIS Netherlands presented the refurbishment of the 44 year old Amsterdam IJ tunnel. According to Bart the success factors for refurbishment are sufficient time to check the as-built situation and make a 'custom-made' design, combine new techniques with existing infrastructure if they are not end of life, and - last but not least - prepare and communicate with road planners and society. Then, Jan Dirk Chabot of the Swiss Federal Railways (SBB) talked about the safety improvement of existing rail tunnels from a tunnel operator's view. It appeared that the structural safety of SBB tunnels is guaranteed for more than 150 years and that tunnel safety (self-rescue) is upgraded for a period of approximately 18 years. Handling of groundwater in Swiss rail tunnels is very important for the lifetime of the tunnel structure and the technical equipment. The discussion afterwards was chaired Ornella Segnalini, President of the Italian Administrative Authority for Road Tunnels.



The topic of the next session, chaired by Niels-Peter Hoj, was cost-efficient fire design of tunnels. Antonio Valente of ANAS (Italy) presented the evolution of ANAS tunnel design standards according to national and EU provisions: cost-benefit and safety. He showed amongst others that the annual number of casualties in tunnels has decreased since 2001, although the number of annual incidents has been more or less constant. Fire design of tunnel lining segments was the subject of Alberto Meda, University of Rome Tor Vergata (Italy) and Niels Peter Hoj (Switzerland). The aim is to prepare a bulletin on this topic, helping the designer adopt an efficient approach for road, rail and metro tunnels. Not only conventional tunnels with continuous lining, but also mechanically-excavated tunnels with segmental lining and cut & cover (immersed) tunnels will be addressed. Lessons from real fires will be the basis for this bulletin. The discussion of this session was chaired by Fabio Dattilo, Italian Ministry of the Interior.



Didier Lacroix hands out the ITA COSUF Award to Ying Zhen Li of SP Technical Research Institute.

At the end of the workshop the ITA COSUF Award 2012 for an outstanding contribution to the safety of underground facilities was awarded to Ying Zhen Li of SP Technical Research Institute (Sweden) for his work on fire dynamics in tunnels. It was handed out by the ITA COSUF Chair-man Didier Lacroix. In section 5 a paper on the latest advance of research on tunnel fire dynamics, by the winner of the ITA COSUF Award 2012, is included. After the closing remarks of Didier Lacroix and Mr. Franco Karrer, chairman of the Higher Council for

Public Works, some participant stayed to further enjoy the beautiful city of Rome. Despite of the (even for Roman standards) very hot weather the symposium was very lively and successful. Presentations are available at www.ita-cosuf.org.

6. Report from the Activity Groups

The last meeting of AG1 took place on 21st June in Rome. The agenda was amongst others dedicated to a draft technical programme for the Workshop 2013 in Geneva (Switzerland). One idea was to focus on underground facilities with “large masses” like Chatelêt Station in the Paris Metro, viz. “big underground stations”. A working title “Complex Underground Multipurpose Facilities, challenges and solutions” was proposed.

AG2 Regulations and best practice

AG 2 covers regulations, the state-of-the-art and best-practices in various countries. This includes discussion and comparison of regulations and best-practice procedures from different owners,



networks, projects and the experience gained by them. Currently, AG2 is working on several subjects including best practice on SCADA systems, smoke removal objectives, particularly for underground stations, disabled people in emergency situation, and fire protection on platforms with screen doors.

The activity group meeting in Rome was used to make a plan for the publication of the work currently being done on some these subjects. AG2 is also still looking for someone to lead the interesting subject with regards to disabled people in emergency situation, a subject that is more topical than ever. So, please if you want to get involved with this or any other topics within the scope of the AG2, do not hesitate to contact any of the two co-leaders.

AG3 Research and new findings

Currently AG3 is driven by two main objectives. One the one hand we still try to keep our members up to the latest research projects and their results in the field of underground safety and security. Tackling this task is rather easy since many members of AG3 are also involved in some of the bigger R&D-projects within the EU as well as the national research programs which are currently carried out. On the other hand we want to share different perspectives and information regarding different national developments in terms of carrying out risks analyses for underground facilities. In the course of our Rome-meeting, for example, the group developed a lively discussion about the different national approaches for road tunnels, which are still not harmonized, even not throughout the EU. In the oversee able future the group therefore plans to come up with some hints for best practices in terms of CFD-Simulations and QRA. Any additional input from the members is welcome and we're already looking forward to our next meeting in Madrid.

AG4 Road Tunnel Safety Officers

As reported in the previous newsletter, the 2nd European Tunnel Safety Officers Forum was held in Brussels in January of this year. During this Forum it was decided to continue organizing this Forum on a two-year basis. The preparation of the next Forum, planned to take place in March 2014, is a major objective of AG4. The working title of the 3rd Forum is: "Tunnel safety: a joint effort". The goal of the Forum is to be a platform for the European TSOs where experiences can be exchanged and workshops on prepared topics take place. The ambition is to have a two-day event and combine the Forum with a site visit. To further identify the interest of the AG4 members an inquiry will be sent out covering various topics discussed during the meeting of AG4 in Rome.

7. Publication of ITA COSUF 2012 Award Winner

The ITA COSUF Award is annually granted to a student or young researcher who has recently completed an outstanding research work in theory and/or practice in the area of safety and/or security of underground facilities. The application deadline for the ITA COSUF Award 2013 will be end of February 2013. More information will be given next November on the ITA COSUF website.



As already mentioned, Ying Zhen Li has won the ITA COSUF 2012 Award. He was asked to draft a contribution to this newsletter, which can be found below.

Latest advance of research on tunnel fire dynamics

Ying Zhen Li, SP Technical Research Institute of Sweden, Email: yingzhen.li@sp.se

Latest advance of tunnel fire dynamics is presented, including design fire, ceiling gas temperature, flame length and smoke control issues.

Design fire

The fire size, i.e. maximum heat release rate, is a key issue in tunnel fire safety design. For a fire in a vehicle with exposed fuels or tarpaulin or fragile structure, the fire is generally fuel controlled or well ventilated. It has been found in such a tunnel fire that the heat release rate per unit area of the fuel approaches constant for a specific fuel, independent of the ventilation. This suggests that the maximum heat release rate can be estimated using the total fuel surface area and the combustion properties. In such cases, the effect of tunnel geometry on fire size is also limited due to the essence of three-dimensional combustion of solid fuels. However, the fire growth rate, an even more important parameter for evacuation, is significantly influenced by ventilation. In such cases it increases linearly with ventilation velocity within a wide range.

For a fire in a well enclosed vehicle, e.g. a train, the fire could probably get fully developed and the fire size depends on the openings, i.e. doors and windows. In such fires, the ventilation and geometry also only have quite limited influence on the fire size, if the ventilation flows in tunnel are sufficient for combustion. The ventilation could also have insignificant effect on fire growth rate, except a

longitudinal flow is produced in the vehicle such as a cracked door or window in the front or at the back.

Ceiling gas temperature

Maximum ceiling gas temperature

The maximum ceiling gas temperature is useful in fire detection design and structural analysis while exposed to a large tunnel fire. A robust correlation has been found which correlates heat release rate, ventilation velocity, effective tunnel height and geometry of the fire source with the maximum ceiling gas temperature. These are the key parameters and tunnel width only has an insignificant effect.

For a small fire in a tunnel, the maximum excess gas temperature beneath the tunnel ceiling increases linearly with heat release rate and is inversely proportional to longitudinal ventilation velocity for the velocity greater than a certain value, which is called "high ventilation" here, see Figure 1. A general case is a tunnel with longitudinal ventilation. However, below this certain value the maximum gas excess temperature beneath the tunnel ceiling varies as the two-thirds power of the heat release rate, independent of the longitudinal ventilation velocity.

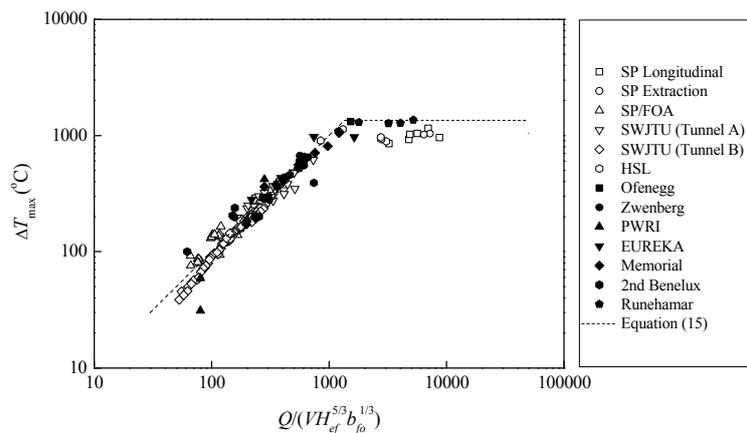


Figure 1. The maximum excess gas temperature beneath tunnel ceiling (High ventilation). ΔT_{max} is maximum excess gas temperature, Q is heat release rate, V is ventilation velocity, H_{ef} is effective tunnel height and b_{fo} is equivalent radius of the fire source.

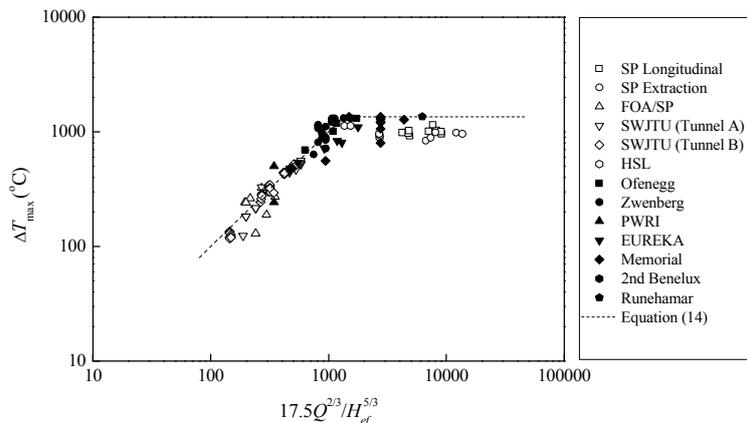


Figure 2. The maximum excess gas temperature beneath tunnel ceiling (Low ventilation).

This region is called “low ventilation” here, see Figure 2. A general case is a tunnel with natural ventilation or transverse ventilation. In both regions, the maximum gas excess temperature varies as a $-5/3$ power law of the effective tunnel height, i.e. the distance between bottom of the fire source and the tunnel ceiling.

For a large fire in a tunnel, i.e. when the flame impinges on the ceiling and extends along the tunnel ceiling, it was found that the maximum excess gas temperature beneath the ceiling approaches a constant value, regardless of ventilation, see Figure 1 and Figure 2. The maximum excess gas temperature beneath the tunnel ceiling is found to be 1350 °C, which is the upper limit for a maximum excess gas temperature obtained from large scale tunnel tests. It could vary somewhat from one case to another, dependent on specific conditions for any given tunnel fire, such as thermal properties of tunnel structure and duration of high temperature, but this proposed value could be considered as a conservative value.

The correlation creates a bridge between the time-temperature curves and other parameters such as heat release rate, ventilation and tunnel geometry. It can be applied to create a specific time-temperature curve in a given scenario, or to convert a standardized time-temperature curve to corresponding fire curve for a given tunnel scenario. It’s a very useful tool for tunnel structure protection and fire detection.

Ceiling gas temperature distribution along the tunnel

The ceiling gas temperature along the tunnel approximately follows decaying exponential functions. A dimensionless distance away from the fire source was found to be able to correlate well with data from model and large scale tests. The proposed dimensionless equation is quite robust which is capable of estimating the ceiling gas temperature for different tunnel geometries. For a very large fire in a tunnel, data from both model scale tests and Runehamar tests confirmed that the distribution of temperature beneath the ceiling has an offset (virtual fire origin). The reason is due to the continuous flame which impinges on the ceiling and extends along the tunnel.

Flame length

In a large tunnel fire, the flame impinges on the ceiling and extends along the tunnel ceiling. The horizontal distance between fire source and flame tip is so-called flame length in a tunnel fire. The flame length actually represents a volume of hot gases with high temperature which contributes to fire spread to neighboring vehicles to a large extent. In a well ventilated tunnel fire, the flame length is found to be nearly independent of the ventilation velocity. The main influencing factors are the heat release rate and the tunnel geometry. The flame length increases linearly with the heat release rate. The tunnel width, instead of tunnel height, plays an important role in the flame length. Wider tunnel results in a shorter flame length for a certain fire size.

Smoke control

Longitudinal ventilation

Longitudinal ventilation system is a cost-effective system widely used nowadays. It is found that the critical velocity is underestimated if the critical Froude number of 4.5 is used. The simple piecewise function shows a better correlation with the tests results. The backlayering length was related to the ratio of ventilation velocity to critical velocity. It is found that the relation between this ratio and dimensionless backlayering length follows an exponential relation. For small fires, the backlayering length varies as the one-third power of the modified Richardson Number and becomes almost independent of heat release rate at higher heat release rate, i.e. it only depends on ventilation velocity. The vehicle obstruction also has an influence on critical velocity and backlayering length. The reduction rate of critical velocity due to obstruction is slightly larger than tunnel blockage ratio. In other words, the local velocities under the critical conditions are closely the same, regardless of the vehicle obstruction. The backlayering with tunnel blockage is shorter for a certain ratio of ventilation velocity to critical velocity.



Point extraction

The point extraction system extracts smoke directly from the fire site and has apparent advantage if the extraction capacity is enough to control the smoke. Even for a very large tunnel fire, an effective extraction system can be established when sufficient fresh air flows are supplied from both sides, to confine the fire and smoke to the zone between the fire source and the extraction vent for a single point extraction ventilation system, or between two extraction vents for a two point extraction ventilation system. The velocities from both sides should be over critical velocity for longitudinal ventilation.

Cross-passage and rescue station

The critical velocity in a cross-passage is defined as the minimum ventilation velocity through an opened fireproof door that can prevent smoke spreading into a cross-passage.

The cross-passage discussed here could be one between twin tunnels or an evacuation passage in a rescue station. The critical velocity in a tunnel cross-passage increases with door height and heat release rate and decreases with tunnel ventilation velocity, not sensitive to door width. It also decreases due to obstruction of the train at a rate slightly lower than the tunnel blockage ratio. It is found that height of the fireproof door is the key parameter in design. Gas temperature beside the door in a cross-passage is well correlated with critical velocity in the cross-passage. This gas temperature is not sensitive to air velocity through the door. The gas temperature under critical condition, i.e. critical gas temperature, can be regarded as a characteristic gas temperature beside the door. The smoke layer height beside the door is directly related to door height. A door height of 2.2 m was proposed for cross-passages.

8. Future ITA COSUF events

ITA COSUF workshops and activity group meetings

25-26 October 2012 ITA COSUF Workshop, AG and SB meetings, Madrid (Spain)

Activity groups will meet on 25 October afternoon. A site visit to Calle 30 will be organised in the evening.

A workshop on 26 October will be devoted to "Safety in complex underground facilities". (see section 4 above)

June 2013 ITA COSUF Open Workshop 2013 and General Assembly, AG meetings, Geneva (Switzerland)

This AG meetings will take place on 3 June afternoon and the workshop will be organised on 4 June, in conjunction with the ITA World Tunnel Congress, which will take place in Geneva from 31 May till 7 June 2013

Other events organised or endorsed by ITA COSUF

7-9 November 2012 13th World Conference of ACUUS (Associated Research Centres for Urban Underground Space), Singapore

During this conference, which is devoted to "Underground Space Development – Opportunities and Challenges", ITA COSUF organises a one-day workshop on "Safety and Security of Underground Operations".

For all enquiries to ITA COSUF membership please contact Ben van den Horn
ben.vandenhorn@arcadis.nl
<http://cosuf.ita-aites.org>



9. ITA COSUF member introduction: Stuva

STUVA Research Association for Underground Transportation Facilities

STUVA is working since more than 50 years in basic research covering all aspects of tunnel construction and operation as well as safety in underground facilities. It is a non-profit organisation seated in Germany with about 240 corporate members, comprising all major players in the field of underground construction.



STUVA has participated since years in several European research projects with the subject of fire safety & security in tunnels, such as FIT, UPTUN, L-surF, UpSafety and has further carried out or coordinated national German research projects on fire safety. In the area of road tunnels, STUVA has worked for more than 15 years in international PIARC working groups to improve fire protection in road tunnels.

As operational safety of underground facilities is a core field of activities already for decades, STUVA essentially initiated the foundation of ITA-COSUF. STUVA's former managing director Prof. Alfred Haack held the chairmanship of ITA-COSUF until mid-2007.

Services

STUVA possesses expert knowledge and decades of experience in the field of operational safety in all kinds of underground facilities such as road-, rail- and metro tunnels and stations.

We are your competent partner for:

- Compilation of holistic fire protection concepts for constructions in underground such as tunnels, metro stations and caverns
- CFD calculations for determination of time dependent spreading of fumes, temperature and toxic gases
- Numerical simulations of evacuation scenarios on the basis of an individual continuous model and analytical calculations according to different procedures (NFPA etc.)
- Planning and performing as well as consulting for fire and smoke tests for acceptance of structures and check of technical equipment
- Evacuation tests with people on site
- Independent reviewing of safety concepts
- National and international research projects
- Providing expert opinions
- Consulting for large scale testing

Further unique testing facilities at our headquarters and the biannual "STUVA Conference" worldwide known as a frequent meeting place for the international tunnelling family are only a few attributes of STUVA.

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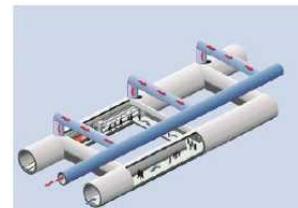


References in the field of operational safety and security

Within the scope of **SOLIT²** – Safety of life in tunnels 2 – the efficiency of water mist fire fighting systems in conjunction with fire ventilation in road tunnels was determined based on more than 30 fire tests in scale 1:1 in 2011 with special focus on compensation potential of safety measures.



The **Gotthard Base Tunnel** in Switzerland with two tubes each 57 km in length will be the longest tunnel in the world after its completion in 2016. In case of fire the high speed trains shall enter an emergency station where better survival conditions are present than in the running tunnel. In this context also extended fire and smoke simulations had to be performed.



The **North-South line in Cologne** will significantly reduce the travel time from the southern parts of Cologne to the city centre as of 2019. The seven underground stations are designed in a modern way of which the use of fireproof glazing was to be planned. Furthermore, CFD-based calculations of smoke and evacuation simulations were carried out and construction-related consultancy services were offered.

